CONTROL OF PROTEOLYTIC AND LIPOLYTIC BACTERIA IN COMMINUTED BEEF

N.G. Marriott, A.M. Ahmed, H.A. Abd El-Rhman, M.M.A. Yassein, and J.R. Claus
Virginia Polytechnic Institute and State University, Blacksburg, Virginia, USA and Suez Canal University, Ismalia, Egypt

Keywords: bacteria, discoloration, spoilage, minced

INTRODUCTION

Meat is an important nutrient dense constituent of western diets and ground beef is one of the most popular meat products. Minced beef is versatile, highly nutritive, easy to prepare, relatively inexpensive and used extensively in fast food restaurants.

Spoilage of minced beef is a serious problem in the food industry, because of microbial action. Bacteria normally present on meat surfaces are distributed along with the natural juices throughout the product during the grinding process and meat contains substrates which are highly favorable for the growth of organisms (Kraft, 1992).

Although the initial microbial flora of meat contains both mesophilic and cold tolerant bacteria, the latter group will more likely grow at refrigerated temperatures. Cold tolerant bacteria can be divided into psychrophiles and psychrotrophs (Eddy, 1960). However, psychrophiles, with an optimum growth temperature of 15°C or less, occur only in cold environments and are therefore not usually found in spoilage floras. Psychrotrophs commonly occur in soil, water and the hide of the animals and are responsible for deterioration changes in refrigerated meat (Gill & Newton, 1977).

Most psychrotrophs have proteolytic and lipolytic activity. Proteolytic species can disrupt the meat structure to allow penetration to occur. The necessary proteolytic enzymes are not produced until the spoilage flora are approaching the maximum cell density. Psychrotrophic, lipase producing bacteria are important to the sensory quality of fatty foods because the enzymes are active at low and intermediate temperatures. All of these bacteria (psychrotrophic, proteolytic and lipolytic) are increased during refrigerated storage of minced beef.

Fresh minced meat is commonly marketed at refrigerated (~ 2 to 5°C) temperatures which limits shelf life. According to Mulder (1969), the microbial quality of minced meat without any preservative is still acceptable after storage for 3 days at 1°C, 1 day at 2°C and 24 hr. at 6°C. The microbial spoilage is delayed at chill temperature but not prevented. Limiting product contamination and delay or inhibition of growth of spoilage organisms on the product during fabrication, packaging and storage are major keys to the improvement of fresh meat shelf life.

This study was conducted to detect and ascertain the relationship between proteolytic and lipolytic psychrotrophic bacteria and changes in some physical, microbial and chemical characteristics of fresh minced beef during storage at room and refrigerated temperature. Additional study has included experimentation to improve the quality and shelf life of fresh minced beef.

MATERIALS & METHODS

Samples:

A total of 100 samples of fresh ground beef were designated for part 1 (1 Kg each, aerobically packaged and 30% fat) and part 2, 200 beef samples for each of 7 days postrigor. One sample set consisted of vacuum packaged, top-round cuts uniform in shape collected from three retail stores in the Eastern United States. The samples were aseptically handled in ice box containers and transferred promptly to the Virginia Polytechnic Institute and State University Muscle Foods Laboratory.

In part 1, 70 samples were divided into seven groups and stored at 4°C. Each group was examined periodically after 0, 2.5, 5, 7.5, 10, 12.5 and 15 days, respectively. Thirty samples were divided into three groups and maintained at 22-26°C. Each group was examined after 0, 12, and 24 hr, respectively.

In part 2, 200 samples were classified into five groups. The first groups were kept as controls (without treatment) and the samples were minced in a sterilized mincer and aerobically packaged, then examined after 0, 5, 10, and 15 days storage at 4°C.

The other four groups (40 samples per group) were immersed in 1 and 2% sterilized solution of sodium tripolyphosphate and trisodium phosphate for 15 sec in a sterilized specimen container. All samples were minced in a sterilized mincer and aerobically packaged, then stored at (4°C) and examined after 5, 10, and 15 days. All samples were examined for microbial and chemical indices.

Microbial Indices:

Determination of Total Psychrotrophic Count:

The inoculated plates were incubated at 29°C for 2 days in Standard Plate Count Medium.

Determination of Total Psychrotrophic Proteolytic Counts:

Standard Methods Caseinate Agar was used for the inoculated plates that were incubated at 20°C for 3 days.

Determination of Total Psychrotrophic Lipolytic Count:

Through use of Tributyrin Agar Medium, the inoculated plates were incubated at 20°C for 5-7 days.

Determination of Thiobarbituric Acid:

These values were obtained by the procedure reported by Vyncke (1970).

Determination of Total Volatile Nitrogen:

These values were determined by: Total volatile base = (a-b) 14mg nitrogen/100g.

RESULTS AND DISCUSSION

Total Psychrotrophic Count (TPsC)

The mean logarithmic values of TPsC in minced beef samples treated with 1% STP after storage at 4°C for 5, 10, 15 and 20 days were 2.95, 3.5, 3.95 and 4.75, respectively. The mean values of TPsC in minced beef samples treated with 2% STP after storage at 4°C for 5, 10, 15 and 20 days were 2.15, 2.5, 2.64 and 3.03 respectively. These values were lower ($P<0.05$) than the non-treated samples.

Total Psychrotrophic Proteolytic Count (TPsPC)

The mean log values of TPsPC in minced beef samples treated with 1% STP after storage at 4°C for 5, 10, 15 and 20 days were 3, 3.2, 3.54 and 4.45, respectively. The mean values of TPsPC in minced beef samples treated with 2% STP after storage at 4°C for 5, 10, 15 and 20 days were 1.25, 2.2, 2.45 and 2.92 respectively. All counts were lower ($P<0.05$) than the control samples.

Total Psychrotrophic Lipolytic Count (TPsLC)

The mean log values of TPsLC in minced beef samples treated with 1% STP after storage at 4°C for 5, 10, 15 and 20 days were 2.69, 2.8, 2.9 and 3.54 respectively. The mean values of TPsLC of minced beef samples treated with 2% STP after storage at 4°C for 5, 10, 15 and 20 days were 0.8, 2, 2.15 and 2.7 respectively. The TPsLC values for the treated samples were lower ($P<0.05$) than for the controls.

Hydrogen Ion Concentration (pH)

The mean pH values of minced beef samples treated with 1% STP after storage at 4°C for 5, 10, 15 and 20 days were 5.7, 5.8, 5.85 and 5.96 respectively. Mean values of pH for minced beef samples treated with 2% STP after storage at 4°C for 5, 10, 15 and 20 days were 5.6, 5.7, 5.85 and 5.87 respectively.

Total Volatile Nitrogen (TVN)

The TVN values for minced beef samples treated with 1% STP after storage at 4°C for 5, 10, 15 and 20 days were 8.7, 9.85, 10.2 and 10.95, respectively. TVN values for minced beef samples treated with 2% STP after storage at 4°C for 5, 10, 15 and 20 days were 8.35, 8.5, 8.75, and 9.51, respectively.

Thiobarbituric Acid (TBA)

The mean TBA values in minced beef samples treated with 1% STP after storage at 4°C for 5, 10, 15 and 20 days were 0.12, 0.13, 0.14 and 0.18, respectively. Values of minced beef samples treated with 2% STP after storage at 4°C for 5, 10, 15 and 20 days were 0.1, 0.1, 0.11, and 0.18, respectively. Treated samples sustained less rancidity development than the controls.

CONCLUSIONS

Results suggest that fresh minced aerobically packaged meat samples stored at 4°C were still wholesome until 7.5 days. An association existed between the proteolytic bacteria and total volatile nitrogen. Increased total psychrotrophic, proteolytic and lipolytic counts resulted in increased TVN and TBA values respectively.

Sodium tripolyphosphate (STP) and trisodium phosphate (TSP) have an antibacterial effect at both 1 and 2% concentration. Thus, STP at 1% concentration can prolong the microbial shelf life of refrigerated minced beef up to 20 days from production. Since TSP is alkaline, it alters the pH and causes changes in product color.

REFERENCES

Eddy, B.P. 1960. The use and meaning of the term psychrotrophilic. J. Appl. Bacteriol. 23:189-192.

Gill, C.O. and Newton, K.G. 1977. The development of aerobic spoilage flora on meat stored at chill temperatures. J. Appl. Bacteriol. 43:189-192.

Kraft, A.A. 1992. Psychrotrophic bacteria in foods: Disease and spoilage. CRC Press, Inc., London, UK.

Mulder, S.J. 1969. Low temperature storage of minced meat. Conserva. 17(9):233-235.

Vyncke, W. 1970. Direct determination of thiobarbituric acid extract of fish as a measure of oxidative rancidity. Fette. Seifen Astrichmittel, 2:1084-1097.